Sundyne®

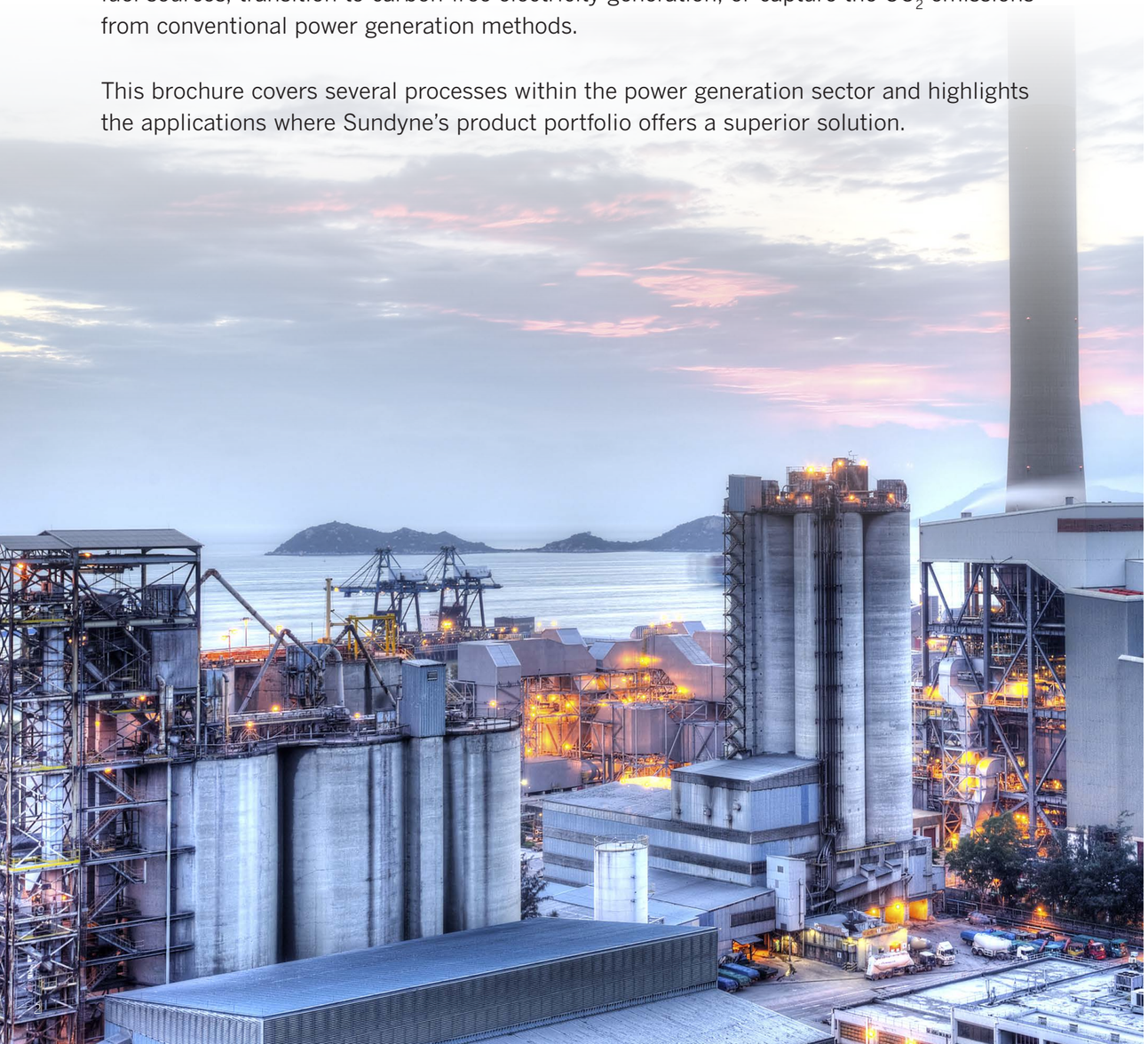
Pumps & Compressors for Power Generation

Sundyne Pumps | Sundyne Compressors | ANSIMAG Sealless Pumps | HMD Kontro Sealless Pumps | Marelli Bombas | PPI Diaphragm Compressors | SUNFLO®

How is Sundyne Equipment Used in Power Generation?

Sundyne provides a wide range of pumps and compressors used in **conventional** and **low-carbon** power generation. In conventional power generation from fossil fuels, Sundyne's equipment is used in simple cycle (gas turbines), combined cycle (gas and steam turbines), and combined heat and power (CHP) processes. In low-carbon power generation, Sundyne provides the equipment needed to blend or switch to low-carbon fuel sources, transition to carbon-free electricity generation, or capture the CO_2 emissions from conventional power generation methods.

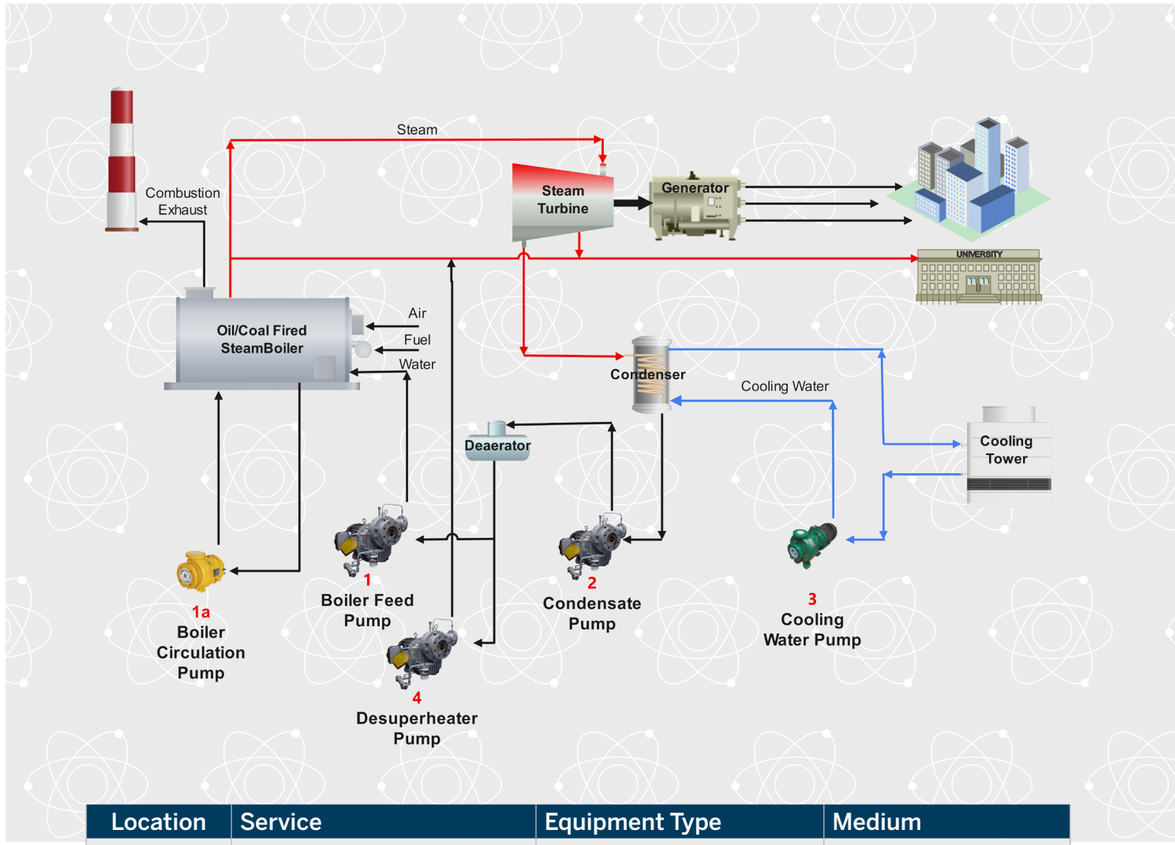
This brochure covers several processes within the power generation sector and highlights the applications where Sundyne's product portfolio offers a superior solution.



Combined Heat and Power (CHP)

Combined Heat and Power (CHP) is a conventional power generation method that produces both electricity and heat, typically for single users (e.g. hospitals, universities, industrial plants). The CHP process typically uses natural gas as a fuel to drive a turbine to produce electricity. The waste heat from the exhaust is then captured via a heat recovery steam generator (HRSG) and used to heat water for district or process heating. By using the waste heat, the CHP process improves energy efficiency. In this way, CHP processes are optimized for maximum energy use and are typically smaller scale (0.1MW to 50 MW).

In CHP plants, Sunflo pumps offer unmatched performance in boiler feedwater, desuperheating, and water injection services due to the robust design of the pump. The multistage performance in a single stage unit offers a small footprint in a simply designed pump which utilizes Sundyne's inducer technology to accommodate for low Net Positive Suction Head available (NPSHa) reducing the need for a booster pump. Along with the robust design, the pump includes a thrust bearing, which is more capable of withstanding suction transient conditions associated with low deaerator (DA) heights than other thrust balancing devices.



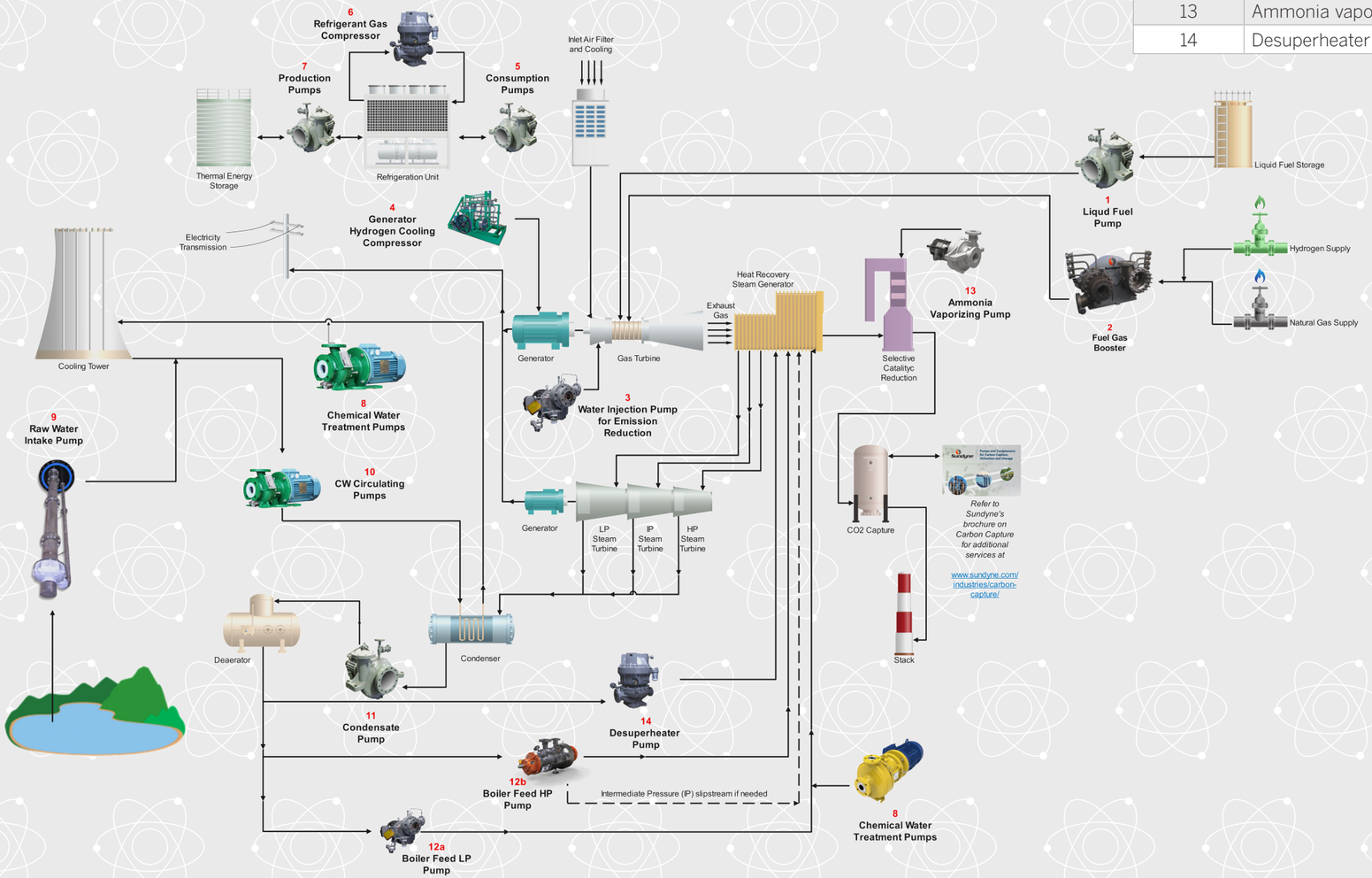
Location	Service	Equipment Type	Medium
1	Boiler Feedwater Pump	Sunflo , LMV, Marelli	BFW
1a	Boiler Circulation Pump	HMD	BFW
2	Condensate Pump	Sunflo or LMV	Condensate Water
3	Cooling Water Pump	Ansimag	Cooling Water
4	Desuperheater Pump	Sunflo or LMV	BFW

Combined Cycle Gas Turbine (CCGT) Power Plants

CCGT power generation is the most common process for utility-scale natural gas-fired power plants. Similar to CHP, a CCGT uses a natural-gas driven turbine to generate electricity. The waste heat from the exhaust of the gas turbine is recovered in a HRSG system. In a CCGT, the waste heat is used for high-pressure steam production. This steam is then used to drive a secondary turbine and generate additional electricity. In this way, CCGT processes are optimized for maximum electricity generation. CCGT processes are typically used for utility-scale power generation (100MW+) by electric utility companies and large-scale industrial sites.

In CCGT plants, Sundyne's Sunflo, LMV and Marelli pump product lines offer proven performance in boiler feedwater, condensate, and other critical process services that demand high reliability for 24/7 steam production. The general process flow diagram below illustrates additional services where Sundyne's portfolio is used in CCGT processes:

Location	Service x Qty. per Plant	Equipment Type	Medium
1	Liquid fuel pump	Marelli	Fuel oil, diesel, biofuels
2	Fuel gas booster	Sundyne LMC, BMC, LF-2000	Natural gas, H_2, Syngas
3	Water injection pumps (NOx, power augmentation)	Sunflo	Water
4	H_2 cooling compressor	PPI	Hydrogen, coolant
5	Consumption pumps	Marelli	Water or cooling medium
6	Refrigerant gas compressor	Sundyne LMC, BMC	Refrigerant gas
7	Production pumps	Marelli	Water or storage medium
8	Chemical water treatment	HMD, Ansimag	Bleach, corrosion inhibitors
9	Raw water intake	Marelli (VS4)	Water
10	CW circulation	Marelli	Water
11	Condensate pumps	Sunflo, LMVs	Water
12 ab	Boiler feedwater pumps (LP, HP)	Sunflo, LMV, Marelli	Water
13	Ammonia vaporizing pump	Marelli, Sealless?	Liquid ammonia
14	Desuperheater pump	LMV, Sunflo	



Low-Carbon Power Generation

Power generation accounts for approximately one-third of global CO_2 emissions – around 14 gigatonnes annually – making it the single largest contributor by sector.[1] These emissions primarily come from fossil fuel fired power plants (e.g. coal, natural gas, and oil). As the global demand for electricity continues to climb, decarbonizing the power generation sector has become increasingly critical. Building a low-carbon power system will be a critical step in achieving the emissions reductions goals set by many countries and companies into the 21st century.

Beyond improving energy and grid efficiencies, there are several solutions available for low-carbon power generation. These can be categorized by:

- **Decarbonizing fossil-power:** post combustion carbon capture on fossil fuel power plants; or low-carbon hydrogen or ammonia blending at coal- or gas-fired power plants
- **Alternative fuels for power:** biomass gasification or waste-to-energy plants, which use non-fossil sources and have a lower lifecycle carbon intensity, and can be combined with carbon capture to further reduce emissions
- **Zero-emission power generation:** renewable electricity (including geothermal) and nuclear power generation

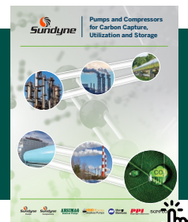
In the following sections, we highlight where Sundyne's pumps and compressors are used in key processes for low-carbon power generation.

Post-Combustion Carbon Capture

Capturing CO_2 for utilization or permanent sequestration can be achieved through a variety of technology processes. These include:

- **Pre-combustion:** removing CO_2 from fossil fuels before combustion to produce syngas
- **Post-combustion:** separating CO_2 from flue gas after fossil fuel or biomass combustion
- **Oxy-fuel combustion:** burning fuel with pure oxygen (rather than air), resulting in a nearly pure CO_2 stream
- **Direct Air Capture:** removing CO_2 directly from the atmosphere

For more information and Sundyne applications, reference our Carbon Capture, Utilization and Storage brochure.



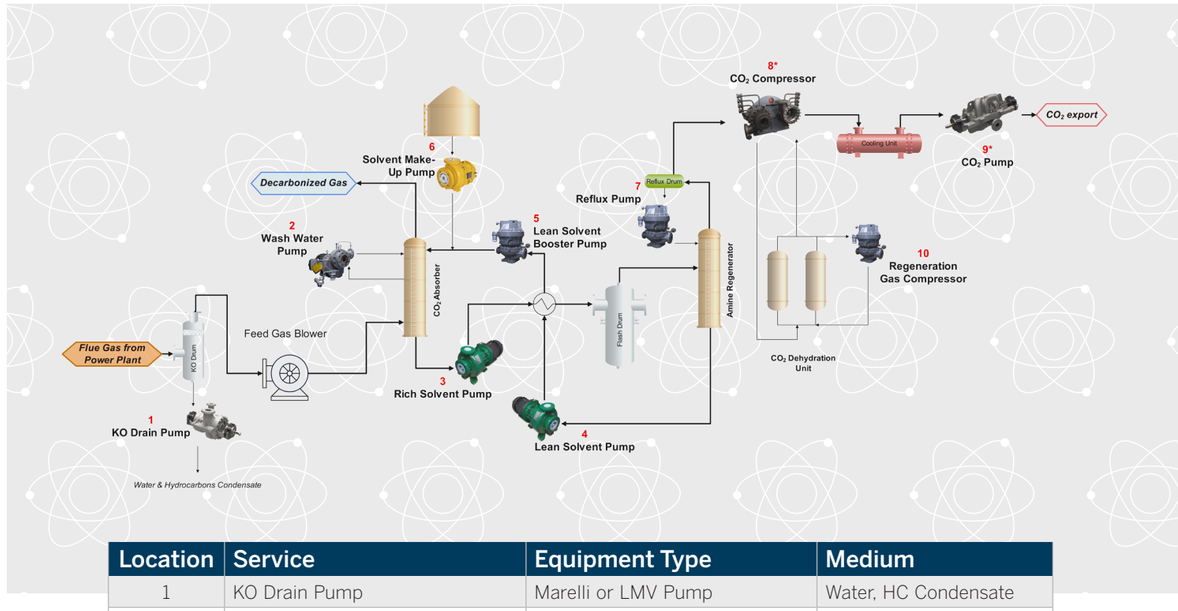
[1] IEA CO_2 Emissions in 2022. https://www.iea.org/reports/co2-emissions-in-2022

One option to decarbonize conventional power generation is post-combustion carbon capture which can be added on to gas-fired or coal-fired power plants to capture the CO_2 from the flue gas without modifying the core process.

Typical post-combustion carbon capture processes use a liquid solvent to absorb CO_2 from the flue gas. The "rich" solvent (holding the CO_2) is then regenerated using steam to release the concentrated CO_2 and refresh the solvent for re-use. The captured CO_2 is compressed and transported for storage or utilization in another process.

In post-combustion carbon capture, Sundyne offers the full suite of rotating equipment solutions, covering all pump and compressor applications, including skid-mounted CO_2-compression packages.

Sundyne's portfolio covers the following critical applications in post-combustion carbon capture:



Location	Service	Equipment Type	Medium
1	KO Drain Pump	Marelli or LMV Pump	Water, HC Condensate
2	Wash Water Pump	Marelli or LMV Pump	Water, Amine
3	Rich Solvent Pump	LMV, HMD, Ansimag pumps	Amine + CO_2
4	Lean Solvent Pump	LMV, HMD, Ansimag pumps	Amine
5	Lean Solvent Booster Pump	LMV, HMD, Ansimag pumps	Amine
6	Solvent Make-Up Pump	LMV, HMD pumps	Amine
7	Reflux Pump	Marelli or LMV pumps	Amine + CO_2
8*	CO_2 Compressor	LF-2000	Wet / Dry CO_2
9*	CO_2 Pump	Marelli BB3, HMP	Liquid CO_2
10	Regeneration Gas Compressor	LMC/BMC or LF-2000	CO_2, Water

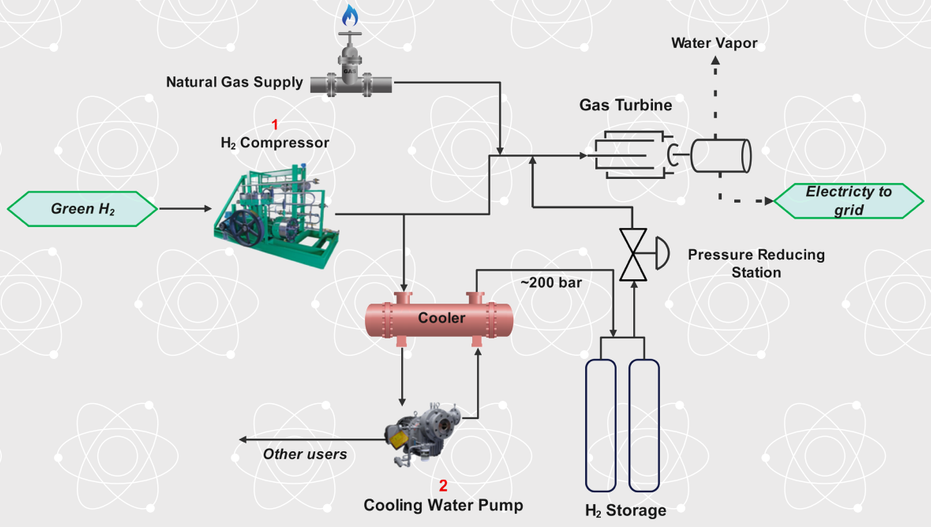
Low-Carbon Hydrogen Blending or Ammonia Co-Firing

Blending a low-carbon fuel source with natural gas or coal is another option to decarbonize conventional power generation. Hydrogen blending involves injecting hydrogen into natural gas systems and co-firing the blended fuel source in gas turbines. Since hydrogen does not product CO_2 emissions when combusted, blending it with natural gas reduces overall emissions while still delivering the energy needed to produce electricity. New turbine and burner design are under development to accommodate 100% hydrogen fuel.

To realize a lifecycle reduction in CO_2 emissions, low-carbon hydrogen is utilized in this application (e.g. **green** or **blue** hydrogen, etc.).

A similar approach can be taken in coal-fired power plants, where low-carbon ammonia can be co-fired with coal. Like hydrogen, ammonia can be produced from renewable sources and produces less CO_2 emissions when combusted compared to coal. There are NOx emissions associated with this approach, and limitations on the blending percentage, but ammonia co-firing offers a lower-carbon option to enable the transition to a cleaner electricity system.

Sundyne's portfolio provides several critical applications in hydrogen blending:



Location	Service	Equipment Type	Medium
1	Hydrogen compressor	PPI	H_2
2	Cooling water pump	Sundyne LMV, Marelli, Sunflo	Water

For more information and Sundyne applications, reference our Clean Hydrogen Value-Chain brochure.

Biomass or Waste Incineration to Power

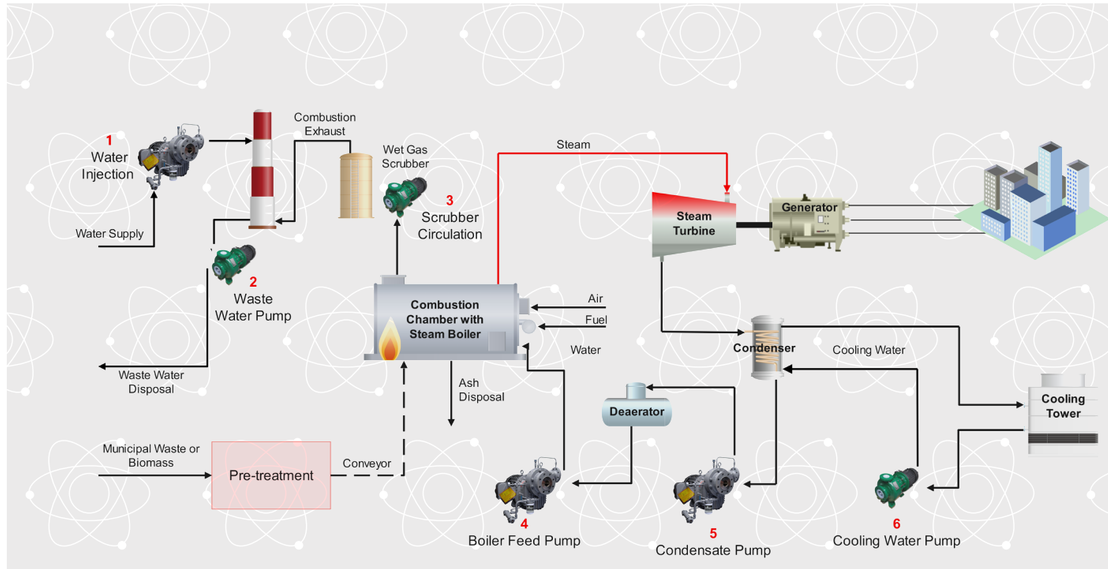
Sustainably sourced biomass or municipal solid waste can be converted into electricity by incineration. This is viewed as a low-carbon electricity generation option because it does not rely on the use of new fossil fuels.

Incineration for power generation involves feedstock collection and pre-treatment, combustion to produce heat and then steam, and driving a steam turbine to produce electricity. Emissions controls systems are common on biomass-to-energy and waste-to-energy plants, and post-combustion carbon capture is also an option to further reduce lifecycle carbon intensity.

Incineration is the most common biomass or waste-to-energy process deployed today. It is typically lower cost to build and operate and can handle a variety of feedstocks but is less efficient than other electricity generation options.

Sunflo pumps are very well suited for water injection used in flue gas scrubbers for emissions control due to the constant pressure provided by the centrifugal pump technology. The small footprint and minimum utilities required also allows for a simple and effective solution for NOx suppression, power augmentation and temperature control.

Sundyne's portfolio provides several critical applications in biomass or waste incineration for power:



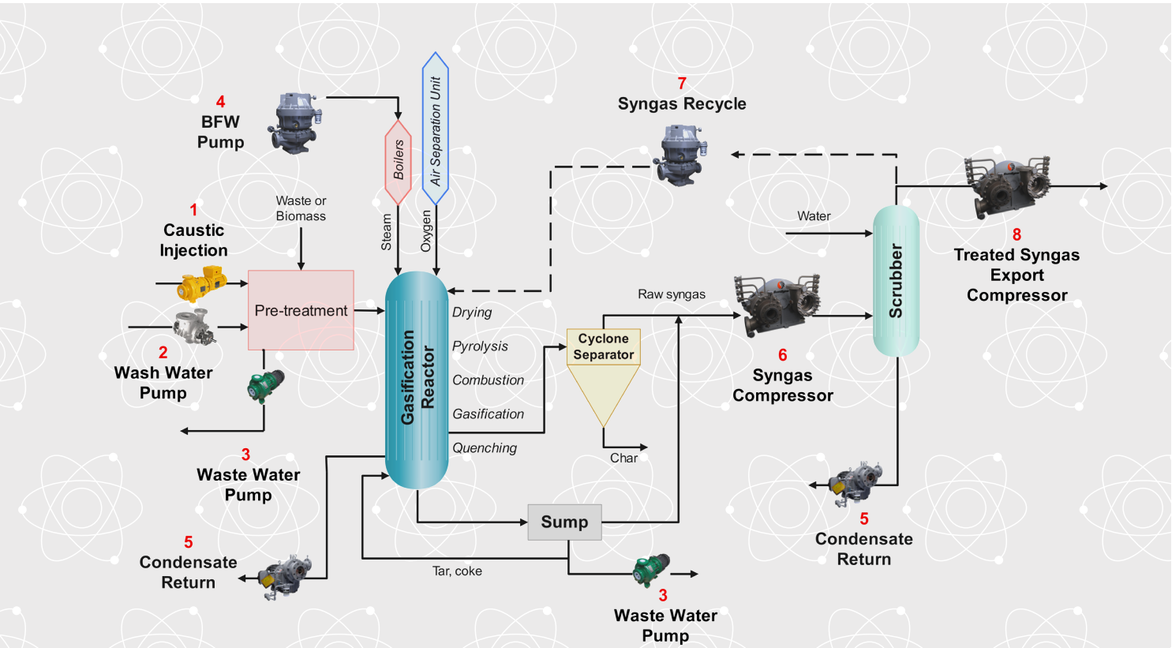
Location	Service	Sundyne Equipment	Fluid
1	Water Injection	Sunflo	Water for emissions control, scrubbing
2	Waste Water	Ansimag	Contaminated water
3	Scrubber Circulation	HMD, Ansimag, Sunflo	Water, can include chemical solvents
4	Boiler Feedwater Pump	Sundyne LMV, Sunflo	Boiler feedwater
5	Condensate Pump	Sunflo	Water
6	Cooling Water Pump	Ansimag, Sunflo	Cooling water

Biomass or Waste Gasification to Power

Gasification is another process that can be used to convert biomass or municipal solid waste into electricity. Gasification involves feedstock collection, pre-treatment and then combustion in a gasification reactor with a limited amount of oxygen. This reaction produces syngas, which can be burned in a conventional power plant to drive a gas turbine and produce electricity.

Gasification is becoming more common for biomass or waste-handling plants. While it typically has a higher cost to build and operate than incineration, it is more efficient in energy recovery. Syngas is also a more valuable end-product as it has multiple value-streams. Syngas can be used directly for electricity generation or it can be used as a feedstock for low-carbon biofuels or other products.

Sundyne's portfolio provides several critical applications in biomass or waste gasification for power:



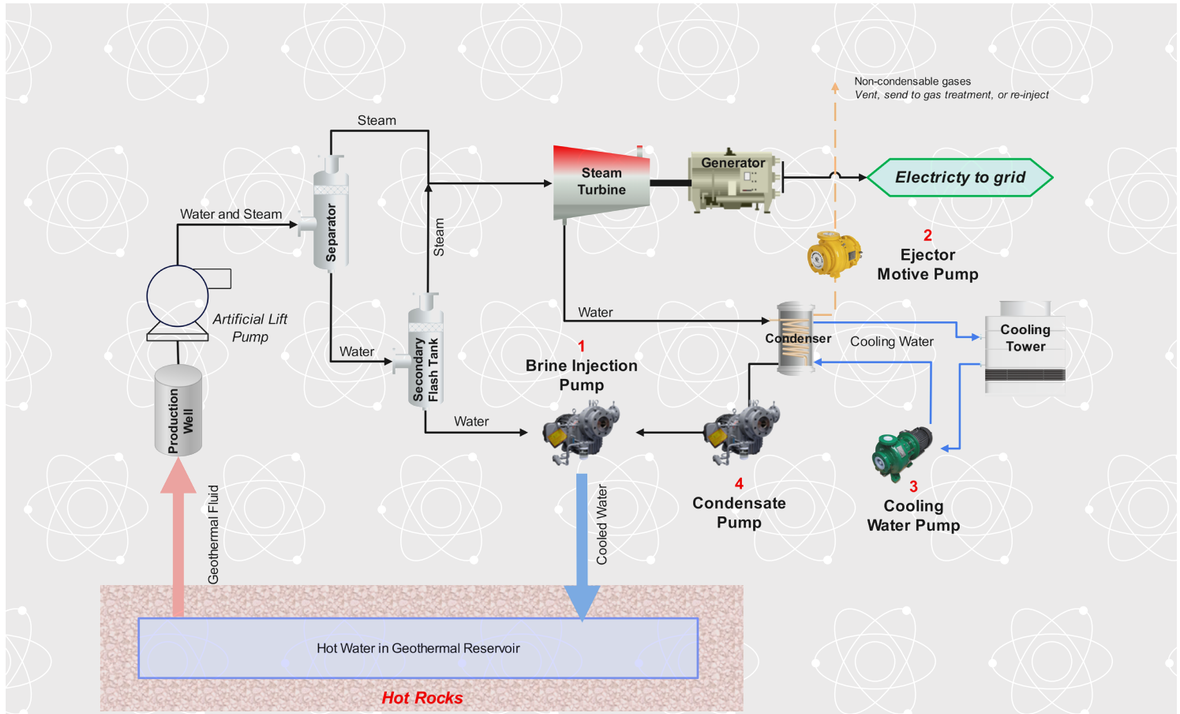
Location	Service	Sundyne Equipment	Fluid
1	Caustic Injection	HMD, Ansimag	KOH or other caustic for de-chlorination
2	Wash Water	Sunflo	Water
3	Waste Water	HMD, Ansimag	Contaminated water
4	Boiler Feedwater Pump	Sundyne LMV, Sunflo	Boiler feed water
5	Condensate Return	Sunflo	Water
6	Syngas Compressor	Sundyne LMC, BMC, LF-2000	Syngas (CO + H2)
7	Syngas Recycle	Sundyne LMC, BMC, LF-2000	Syngas (CO + H2)
8	Treated Syngas Export	Sundyne LMC, BMC, LF-2000	Syngas (CO + H2)

Geothermal Power Production

Geothermal power is the process of using the thermal heat from underground reservoirs to produce electricity. Wells are drilled to bring hot water and steam to the surface. The hot geothermal fluid is used to drive a turbine and generate electricity. Geothermal energy is views as a carbon-free renewable electricity source because the Earth's core is continuously heated and replenished.

There are several technology options used in geothermal power plants. The choice of process technology is based on the condition of the geothermal fluid in the reservoir at the location of the power plant. Dry steam plants use geothermal reservoirs with naturally occurring steam. Flash steam plants use hot water from geothermal reservoirs and "flash" it into steam via pressure drops. Binary cycle plants are used with lower-temperature geothermal reservoirs and require a heat exchange cycle from the geothermal water to a secondary working fluid, with a lower boiling point than water, to then drive a turbine. Flash steam is the most common process today.

Sundyne's portfolio provides several critical applications in flash steam geothermal power plants:



Location	Service	Sundyne Equipment	Medium
1	Brine Injection Pump	Sunflo	Brine (hot salt/mineral-rich water)
2	Ejector Motive Pump	HMD, Ansimag	Non-condensible gases, steam (maintains pressure on back-end of turbine for efficiency)
3	Cooling Water Pump	Ansimag, Sunflo	Cooling water
4	Condensate Pump	Sunflo	Water, brine

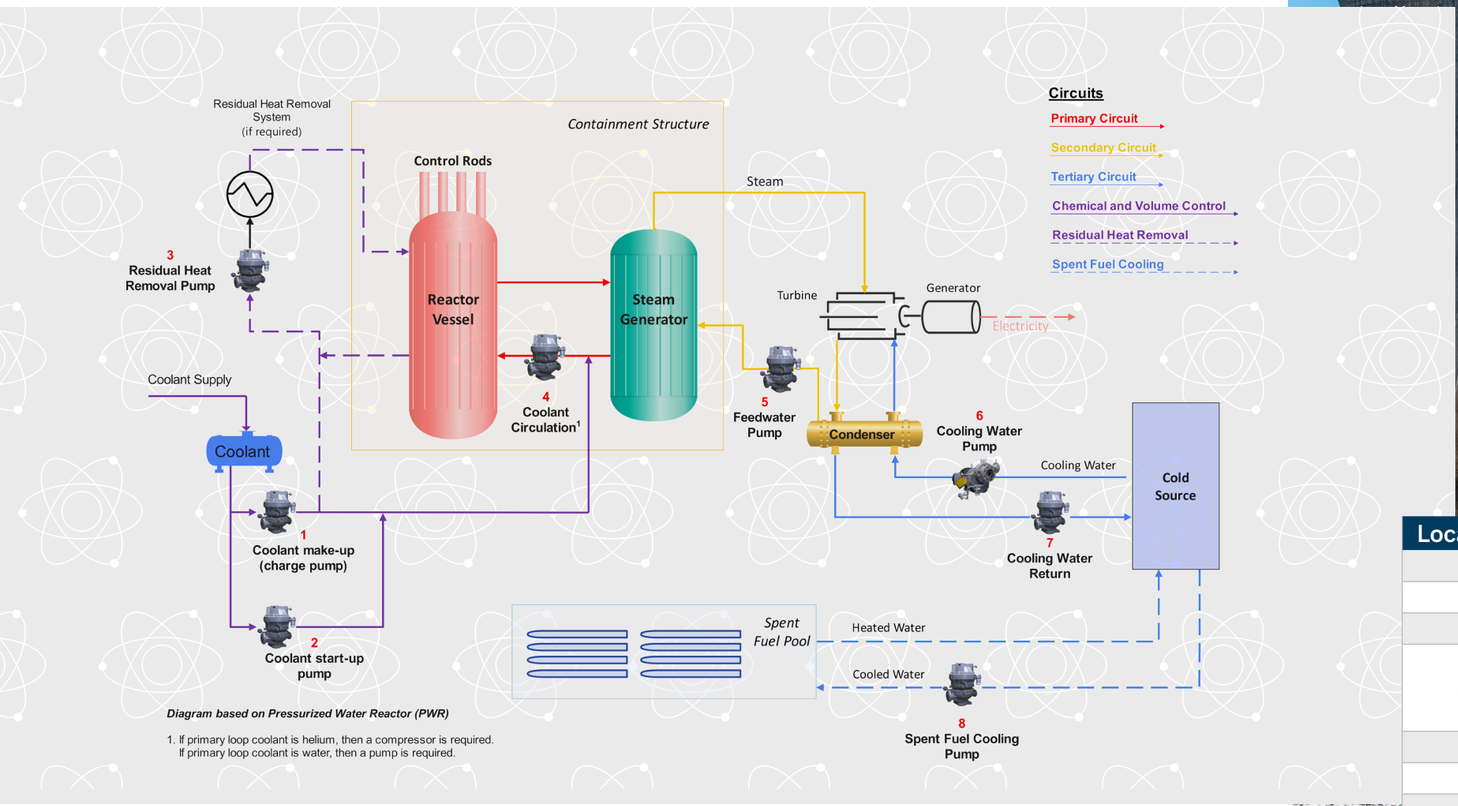
Nuclear Small Modular Reactors

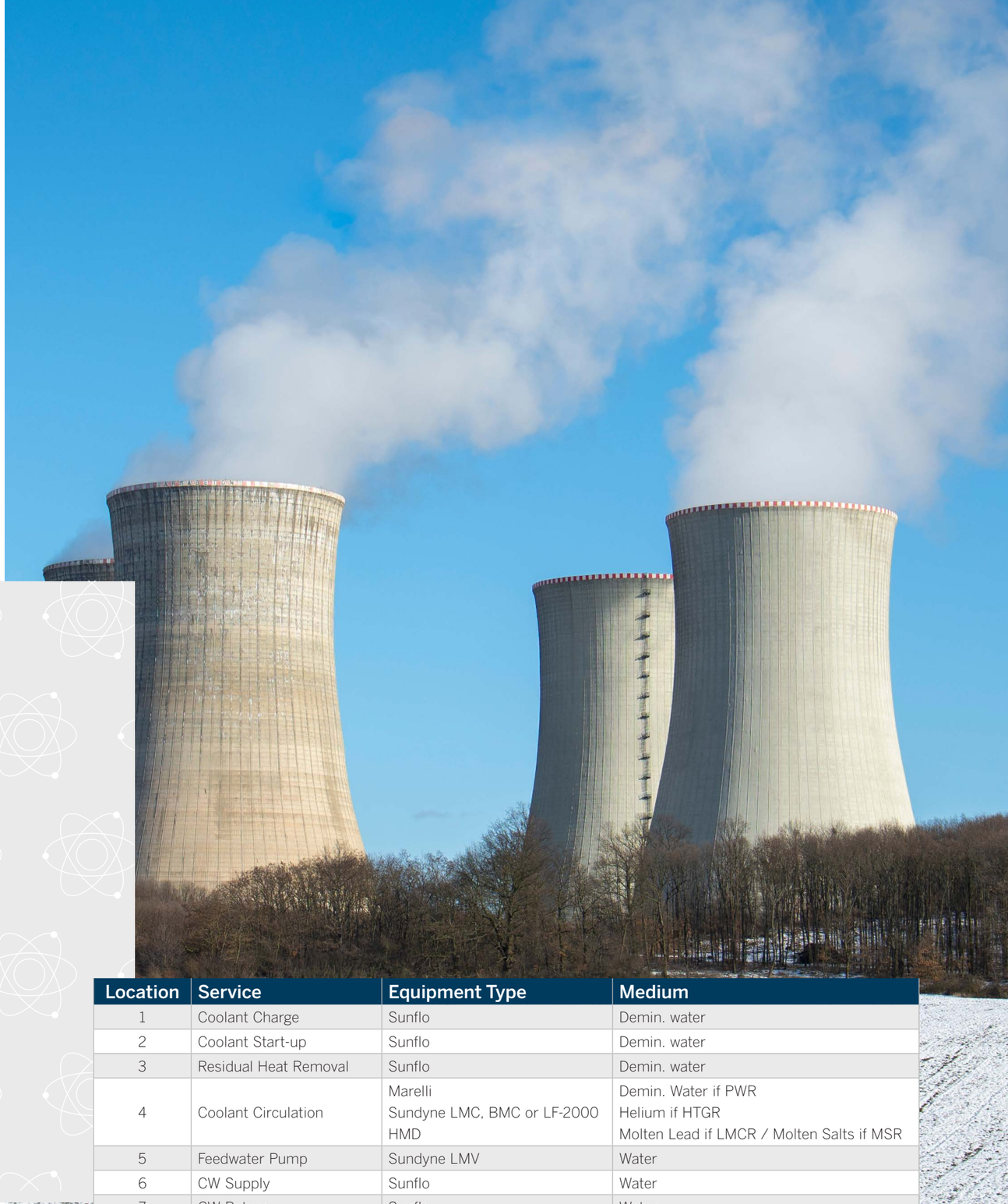
Nuclear power generation uses nuclear fission to produce heat, which is then used to generate steam to drive a turbine and generate electricity. Small Modular Reactors (SMRs) are a type of nuclear fission reactor designed to be standardized and modularized for faster assembly and repeatable installation of up to 300 MW per unit. The production of electricity from nuclear sources is considered carbon-free because no CO_2 is emitted during the energy generation process.

The most common SMR design type is pressurized water reactors (PWR). PWRs use a more mature technology for cooling and moderating the reaction and generate sufficient heat to generate steam for power generation.

High-temperature gas reactors (HTGR) use helium or other gases as the coolant, and typically use graphite as the moderator due to it's high-temperature resistance. HTGRs operate at higher temperatures, so they can be used for electricity generation or for industrial heat generation. Other advanced reactor designs include Molten Salt Reactors (MSR) and Liquid Metal-cooled Reactors (LMR).

Sundyne's portfolio provides several critical applications in nuclear SMR power plants. The choice of rotating equipment depends on the reactor technology and choice of coolant. Sundyne's portfolio offers solutions for many different reactor technologies, including Marelli product pumps for Pressurized Water Reactors (PWR), Sundyne Compressors for High-Temperature Gas-cooled Reactors (HTGR), and HMD sealless magnetic-drive pumps for Molten Salt Reactors (MSR) or Liquid Metal-cooled Reactors (LMR).



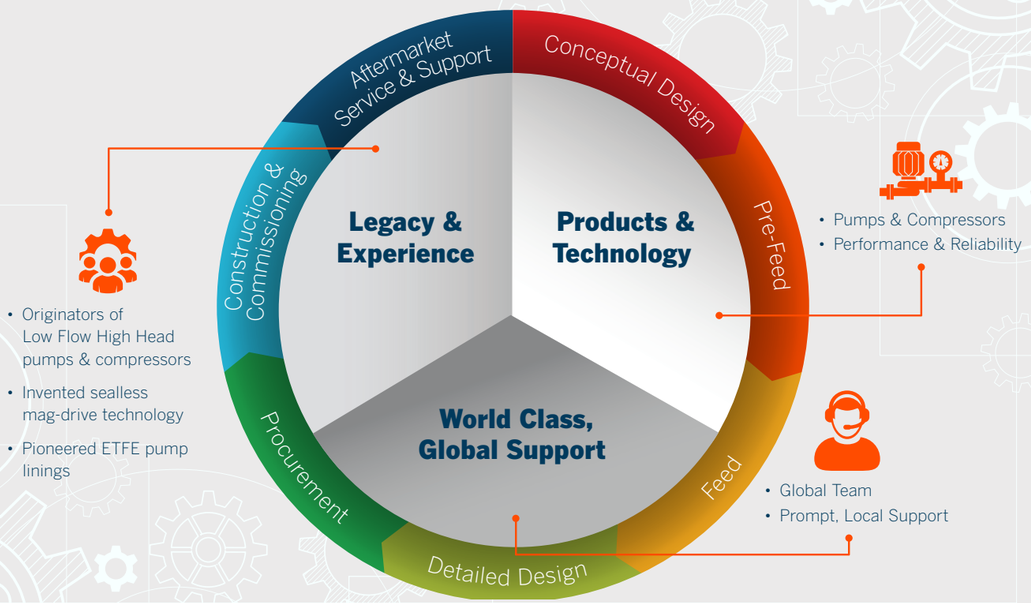


Location	Service	Equipment Type	Medium
1	Coolant Charge	Sunflo	Demin. water
2	Coolant Start-up	Sunflo	Demin. water
3	Residual Heat Removal	Sunflo	Demin. water
4	Coolant Circulation	Marelli Sundyne LMC, BMC or LF-2000 HMD	Demin. Water if PWR Helium if HTGR Molten Lead if LMCR / Molten Salts if MSR
5	Feedwater Pump	Sundyne LMV	Water
6	CW Supply	Sunflo	Water
7	CW Return	Sunflo	Water
8	Spent Fuel Cooling	LMV, Sunflo	Demin. water

Sundyne's Value Proposition for Power Generation

Sundyne's unique combination of technology, expertise and support provides a 360-degree service that spans from pre-FEED to comprehensive 24x7 support. Sundyne's broad product portfolio provides high-quality rotating equipment solutions across a wide-range of applications, and our global network of authorized service centers and aftermarket specialists ensure that our equipment operates at peak reliability and efficiency for our customers.

Total Product Lifecycle, 360° Service



Sundyne LMC, BMC and LF-2000 Compressors

Developed from more than 70 years of technological advancement and with 5,000 units installed worldwide, Sundyne's latest generation of integrally geared compressors delivers the industry's best engineered-for-reliability solution for the Power Generation sector. Fuel gas boosting applications require compact design for easy maintenance, continuous delivery for steady gas supply at pressure, and oil content below 1 ppm to guarantee optimal gas combustion. Sundyne offers a fit-for-purpose skid-mounted design for fast installation and a **compact** footprint, **no pulsation** from the centrifugal technology, and **oil free design** eliminating any potential without the need for filtration. The first maintenance period requiring mechanical seal inspection and routine gearbox inspection is 5 years. Bearing inspection and potential replacement will be at 10-year intervals. Finally, the low speed and high speed gear sets are designed for the compressor lifetime and replacement schedule will be in excess of **20 years**.

Sealless Magnetic Drive Pumps – HMD and ANSIMAG

Sundyne sealless pumps provide optimum safety and environmental protection for a wide range of applications in Power Generation. Featuring a leak-free design that ensures total product containment, Sundyne HMD Kontro metallic and Ansimag ETFE-lined sealless pumps are well-suited for hazardous, hot or corrosive liquids, and applications that are difficult to seal. With the elimination of mechanical seals and ancillary seal support systems, Sundyne sealless pumps provide increased Mean Time Between Repair (MTBR) and uptime, along with simplified operation and maintenance.

Sunflo Pumps

Sunflo pumps provide multistage performance in a single stage pump, designed around simplicity and robustness, reducing the needs for auxiliary pumps, instrumentation and utilities. These pumps provide pulsation-free performance in a compact design able to withstand suction transient conditions, direct start-ups, and capable of meeting low deaerator tank heights without the need of a boost pump.

Sundyne LMV Pumps

Sundyne's LMV pumps are widely used in several Power Gen applications with several critical advantages over competition. They can achieve high speeds with a single stage construction and maintain consistent efficiency over time due to open clearances. Their compact footprint lowers installation cost while features like a removable diffuser simplify maintenance and pump rerating. Additionally, they eliminate the need for pre-warming and are equipped with heavy duty hydrodynamic thrust bearings which are capable of handling 100% thrust loads caused by suction transients from low deaerator heights.

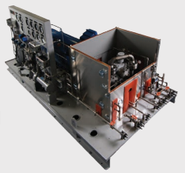
Marelli Pumps

Marelli pumps leverage a track record of more than 60 years in centrifugal pump design, development, manufacturing and service, to fulfill the latest standards for oil & gas, petrochemical and clean energy markets, which requires a variety of API 610 pumps. Marelli pumps are designed for extreme reliability and a wide range of flowrates, to accommodate the most stringent customer specifications.

PPI Compressors

Sundyne's PPI diaphragm compressors are engineered to provide ultra-pure compression for hydrogen, syngas, hydrocarbon products, and critical gases. Ideal for applications requiring small flow rates and high pressures, diaphragm compressor technology stands alone in delivering superior performance where other volumetric compressors fall short. The sealed design ensures exceptional safety and minimal maintenance, making it an optimal choice for demanding industrial and power generation environments.

Sundyne Heavy Duty Multi-stage Pumps (HMP)



Sundyne API 610 heavy duty integrally geared driven pumps are engineered for critical extremely high-head services required for several key applications in Power Generation, which includes CO_2 pumping in carbon capture. Sundyne's unique integrally gear driven pump design offers the ability to optimize efficiency, curve shape, NPSH, runout horsepower and radial loading to provide economical, reliable operation through various combinations of impeller, diffuser, and inducer geometry.

When it comes to Power Generation applications, Sundyne is the **Safer, Better, Best** choice.

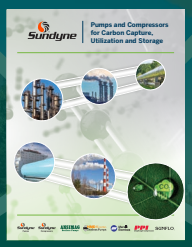
Safer for Operations

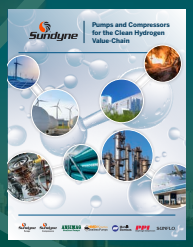
Better for the Environment

Best Total Lifecycle Value

For more information on Sundyne's product fit in Clean Energy Markets, refer to our other clean energy brochures:

- Carbon Capture and Storage
- Clean Hydrogen Value Chain
- Sustainable Aviation Fuel and Renewable Diesel
- Advanced Plastic Recycling Processes





For more information please visit www.sundyne.com and fill out the Contact Sundyne form. A Sundyne representative will contact you.

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